Supplementary Information

A Surfactant-free Approach for Engineering Ultrathin Ti-doped $Ni(OH)_2$ Nanosheet on Carbon Cloth: Experimental and Theoretical Insight into Boosted Alkaline Water Oxidation Activity

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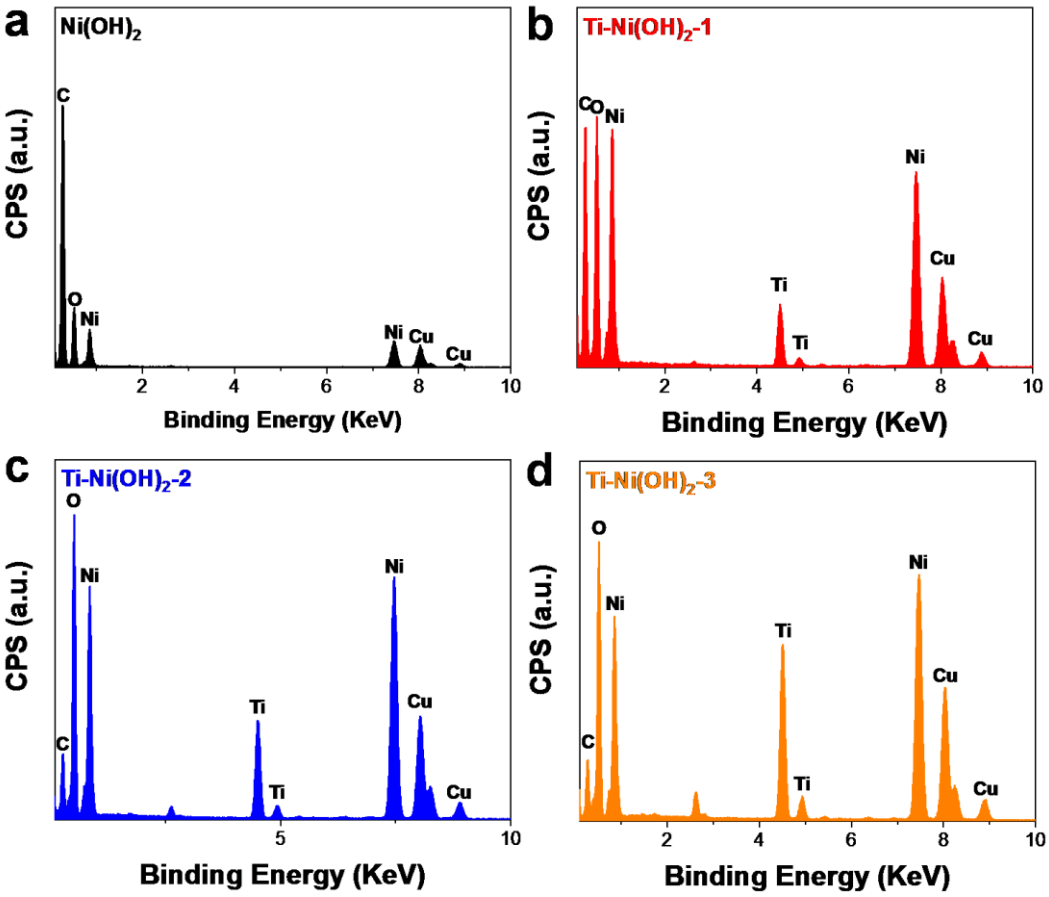

Figure S1. EDX plots of $Ni(OH)_2$ and different Ti-$Ni(OH)_2$.

Table S1. Metallic content of Ni or Ti atoms in Ti-$Ni(OH)_2$ based ICP and EDX.

Materials	ICP		EDX	
	Ni (At%)	Ti (at%)	Ni (At%)	Ti (At%)
$Ni(OH)_2$	100	/	100	/
Ti-$Ni(OH)_2$-1	85.9	14.1	86.6	13.4
Ti-$Ni(OH)_2$-2	75.6	24.4	76.2	23.8
Ti-$Ni(OH)_2$-3	54.2	46.8	49.4	51.6

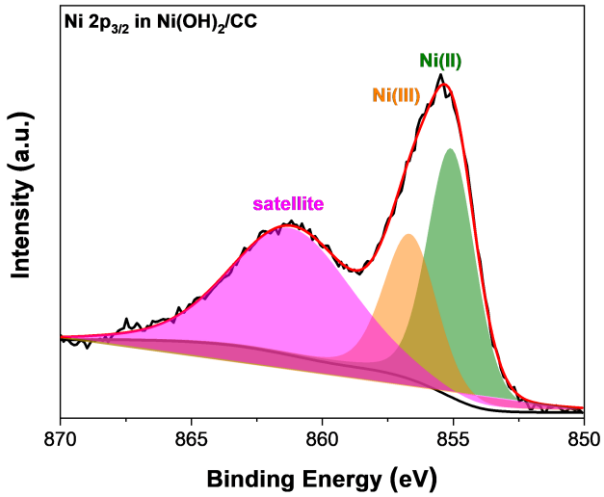

Figure S2. XPS of Ni $2p_{3/2}$ in $Ni(OH)_2$/CC.

Table S2. A table of quantitative analysis of Ni(III)/Ni(II) and Ti(III)/Ti(II) based on the results of XPS.

Materials	Ni(III)/Ni(II)	Ti(III)/Ti(IV)
$Ni(OH)_2$	0.76	/
Ti-$Ni(OH)_2$-1	0.99	1.36
Ti-$Ni(OH)_2$-2	0.88	0.94
Ti-$Ni(OH)_2$-3	0.65	0.68

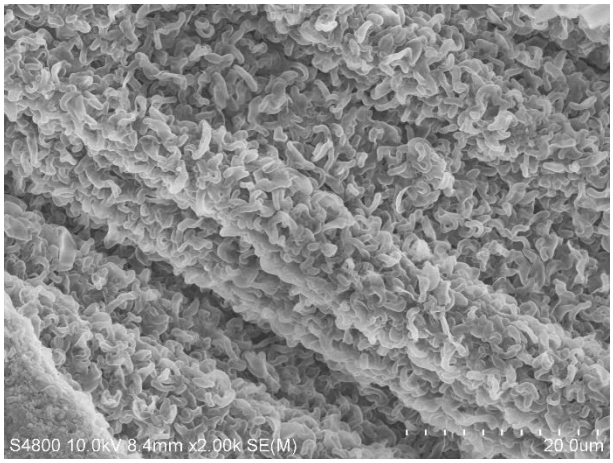

Figure S3. Low-resolution SEM image of $Ni(OH)_2$/CC.

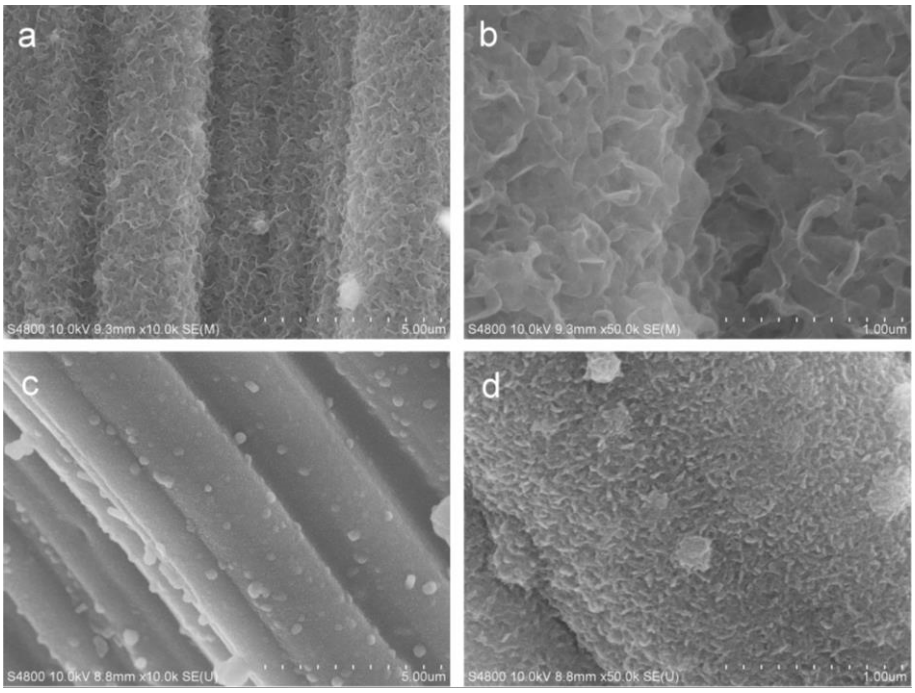

Figure S4. SEM images of Ti-Ni$(OH)_2$-2 NS/CC (a, b) and Ti-Ni$(OH)_2$-3 NS/CC (c, d), respectively.

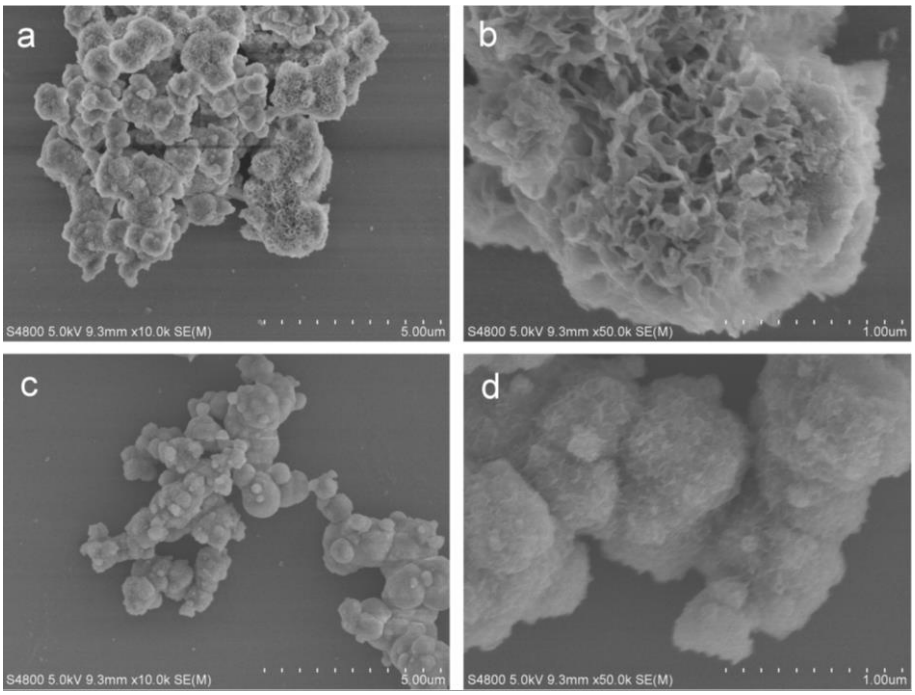

Figure S5. SEM images of Ti-Ni$(OH)_2$-2 NS (a, b) and Ti-Ni$(OH)_2$-3 NS (c, d), respectively.

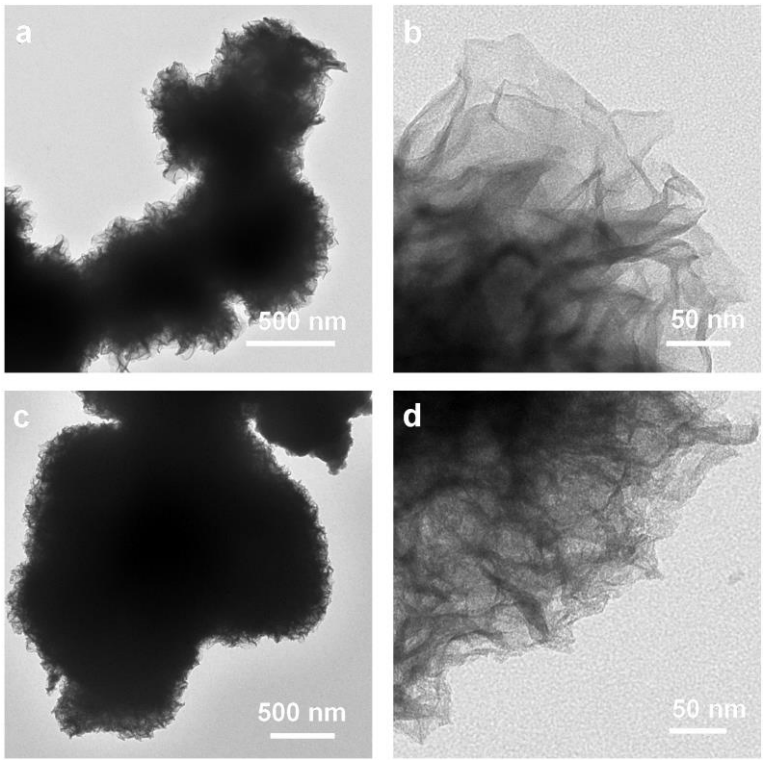

Figure S6. TEM images of Ti-Ni(OH)$_2$-2 NS (a, b) and Ti-Ni(OH)$_2$-3 NS (c, d), respectively.

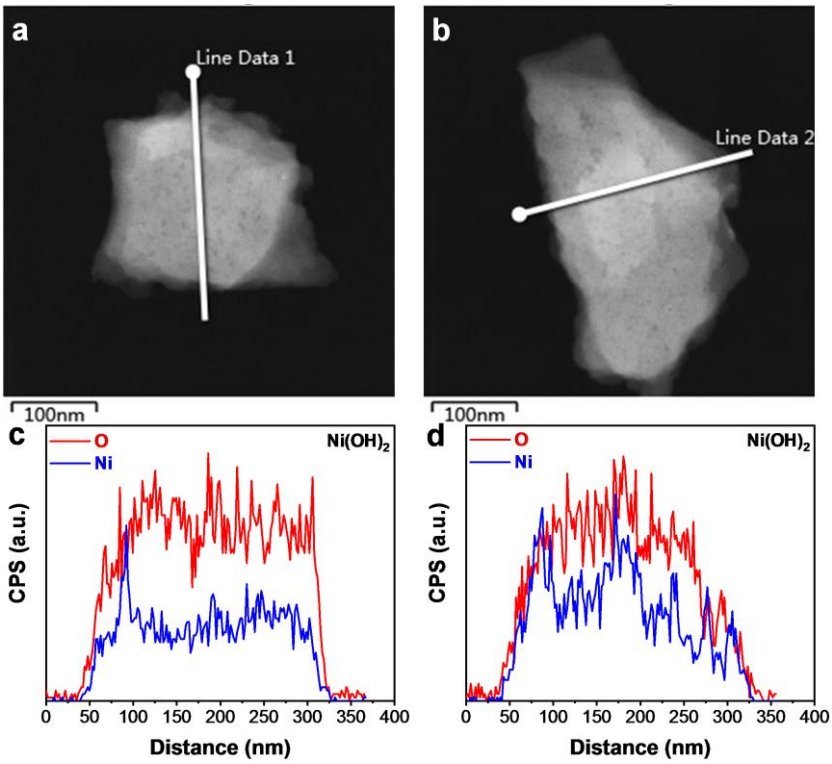

Figure S7. HAADF-STEM images of Ni(OH)$_2$ (a, b). (c) and (d) EDX line scanning spectra of Ni(OH)$_2$ in (a) and (b), respectively.

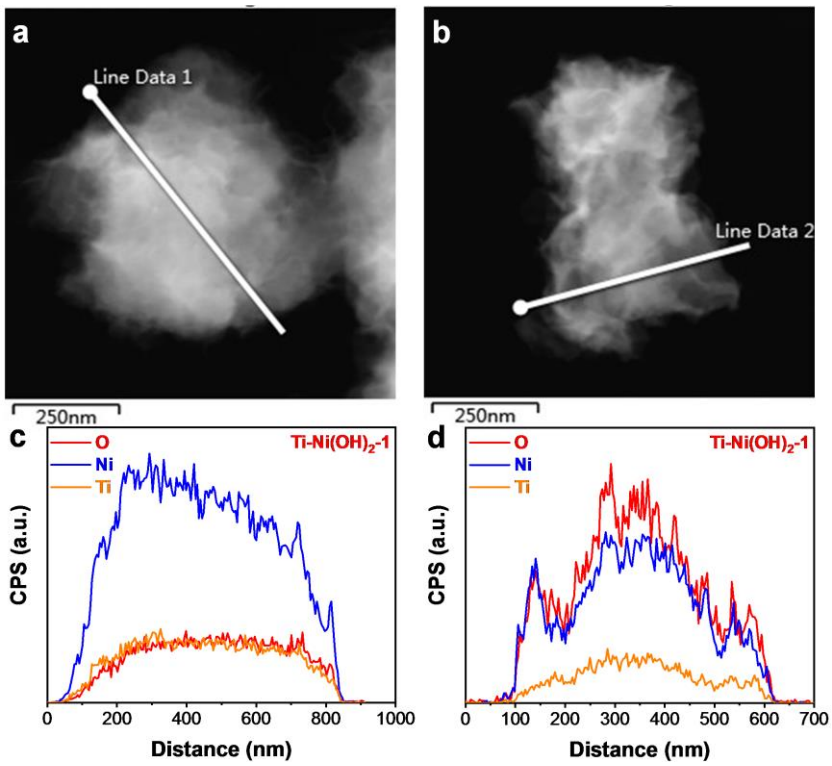

Figure S8. HAADF-STEM images of Ti-Ni(OH)$_2$-1 (a, b). (c) and (d) EDX line scanning spectra of Ti-Ni(OH)$_2$-1 in (a) and (b), respectively.

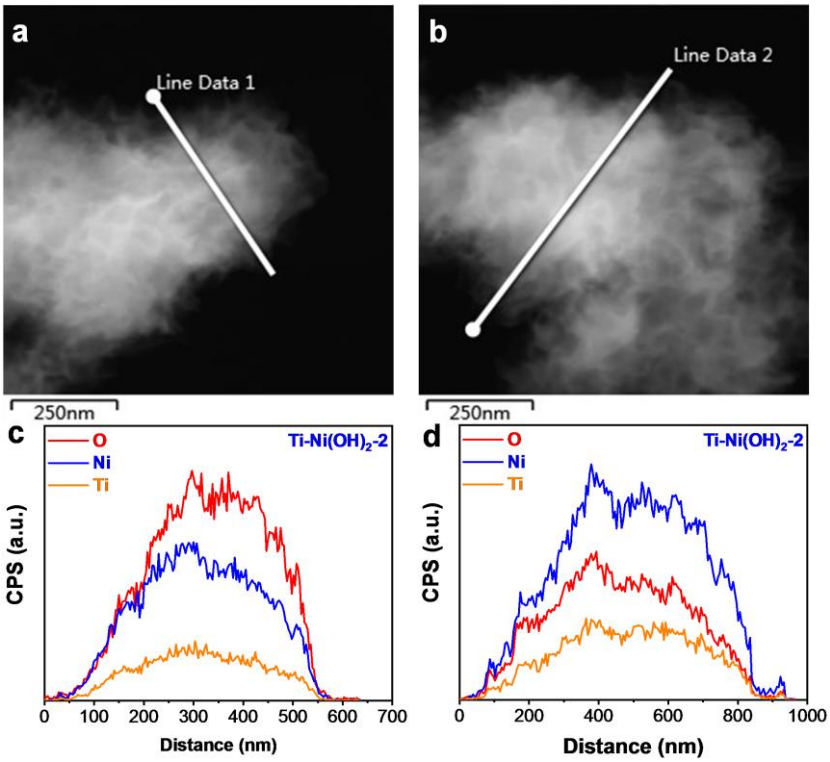

Figure S9. HAADF-STEM images of Ti-Ni(OH)$_2$-2 (a, b). (c) and (d) EDX line scanning spectra of Ti-Ni(OH)$_2$-2 in (a) and (b), respectively.

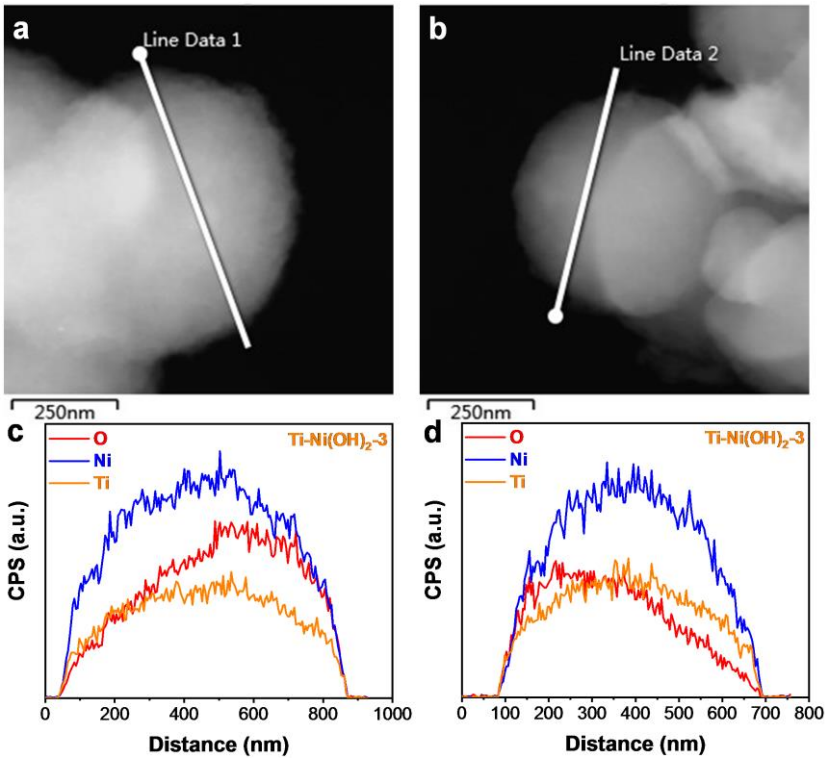

Figure S10. HAADF-STEM images of Ti-Ni(OH)$_2$-3 (a, b). (c) and (d) EDX line scanning spectra of Ti-Ni(OH)$_2$-3 in (a) and (b), respectively.

Table S3. A table of Langmuir type, BET, pore volume and main pore size.

Materials	Ni(OH)$_2$	Ti-Ni(OH)$_2$-1	Ti-Ni(OH)$_2$-2	Ti-Ni(OH)$_2$-3
Langmuir type	IV	IV	IV	IV
BET (m^2 g^{-1})	72.9	200.6	99.2	21.9
Pore Volume (cm^3 g^{-1})	0.155	0.415	0.200	0.064
average pore size (nm)	21.6	20.8	19.1	8.1

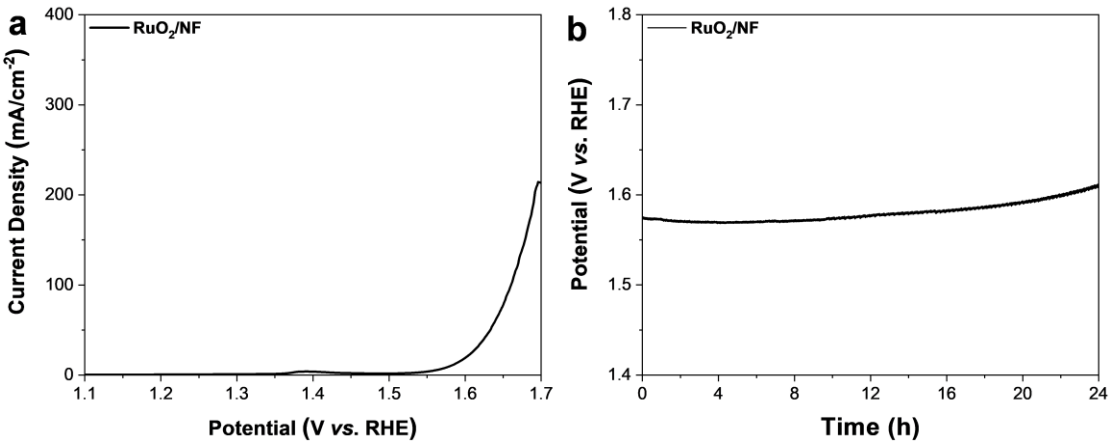

Figure S11. LSV (a) and CP (b) plots of RuO_2/NF in the electrolyte of 1 M KOH, respectively.

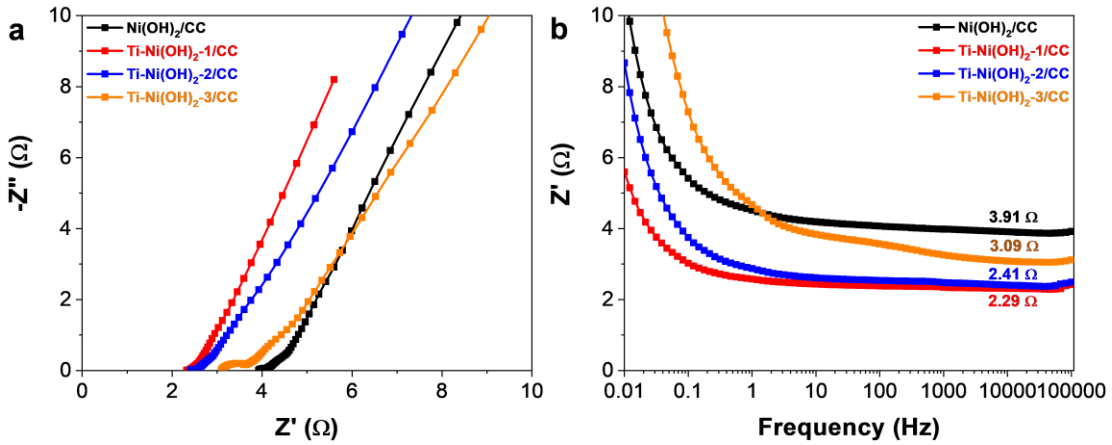

Figure S12. (a) Nyquist plots. (b) the relationship between Z and frequency.

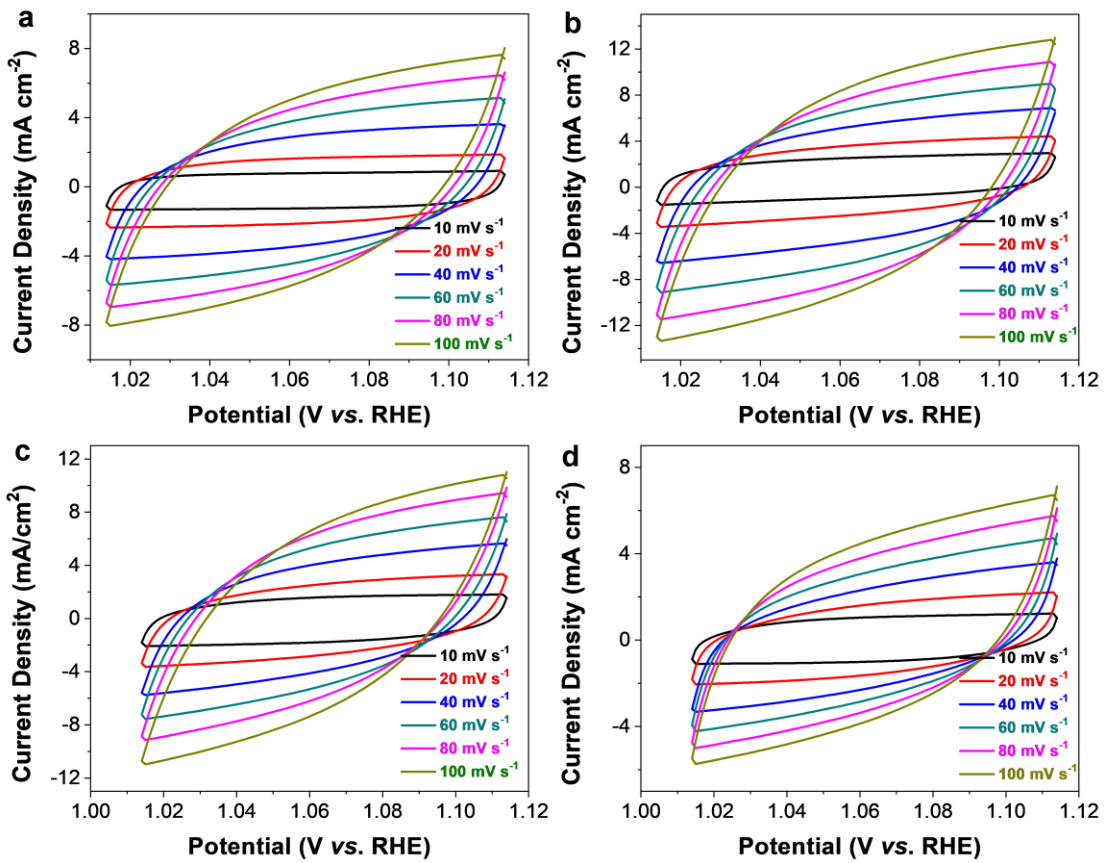

Figure S13. CVs of (a) $Ni(OH)_2$/CC, (b) Ti-$Ni(OH)_2$-1/CC, (c) Ti-$Ni(OH)_2$-2/CC and (d) Ti-$Ni(OH)_2$-3/CC in the electrolytes of 1 M KOH with different scan rates.

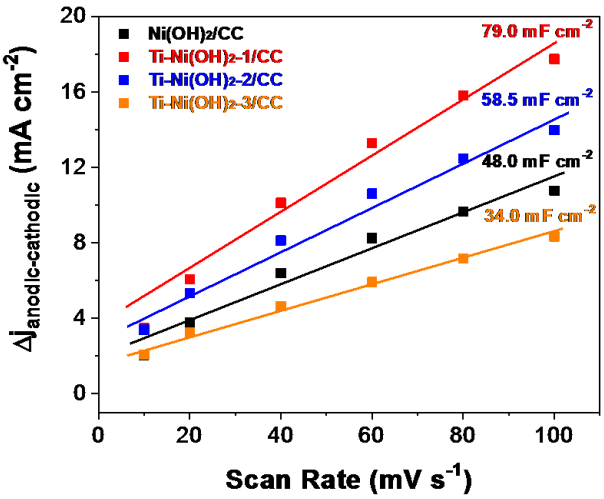

Figure S14. The calculated differential current *vs*. scan rates at 1.05 V *vs*. RHE.

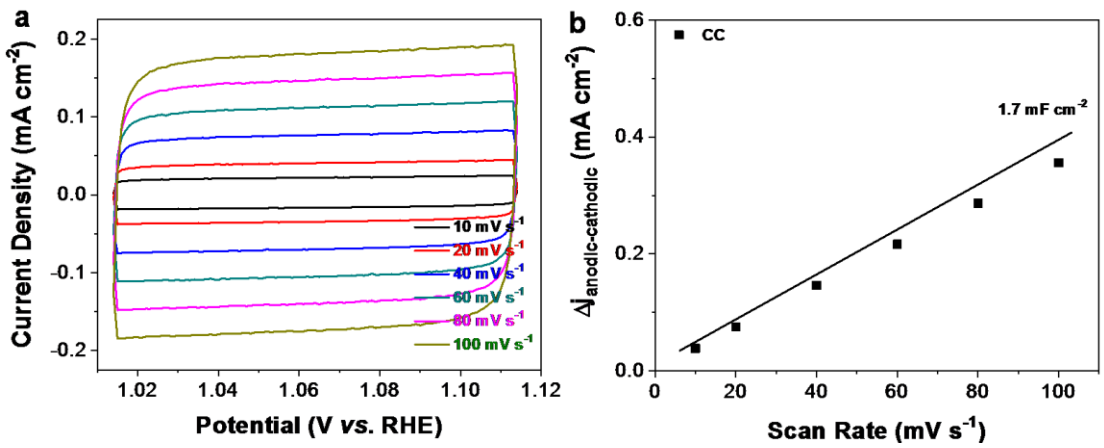

Figure S15. (a) CVs of CC in the electrolytes of 1 M KOH with different scan rates. (b) the calculated differential current *vs*. scan rates at 1.05 V *vs*. RHE.

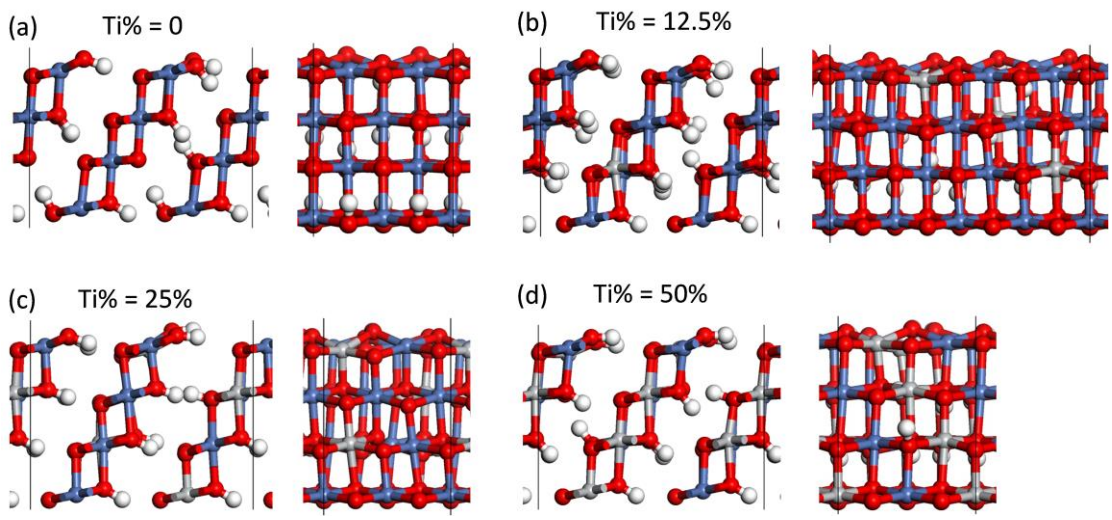

Figure S16. (a) side and top view of $Ni(OH)_2$, Ti-$Ni(OH)_2$-1, Ti-$Ni(OH)_2$-2 and Ti-$Ni(OH)_2$-3. The H, O, Ti and Ni atoms are presented in white, red, grey and pale blue colors, respectively.

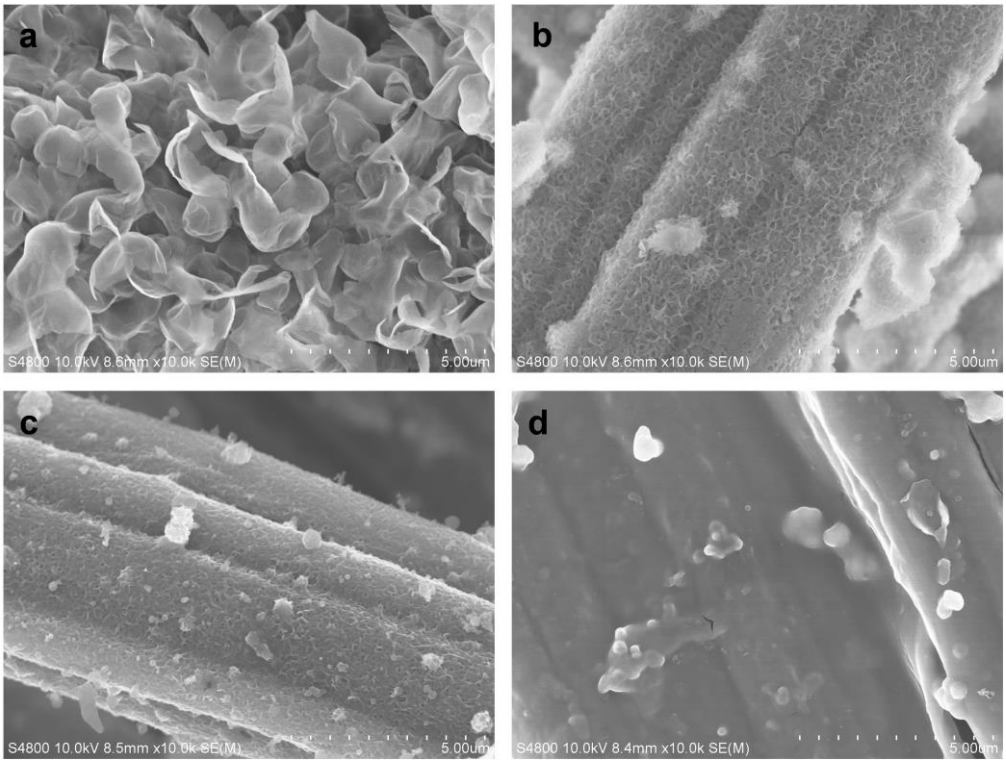

Figure S17. SEM images of (a) $Ni(OH)_2$/CC, (b) Ti-$Ni(OH)_2$-1/CC, (c) Ti-$Ni(OH)_2$-2/CC and (d) $Ni(OH)_2$-3/CC after CP tests, respectively.

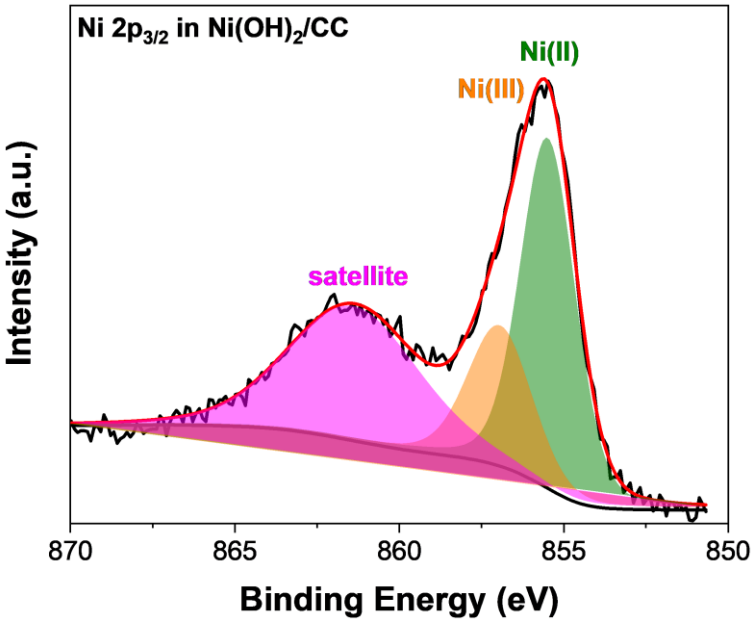

Figure S18. XPS of Ni $2p_{3/2}$ in $Ni(OH)_2$/CC after CP test.

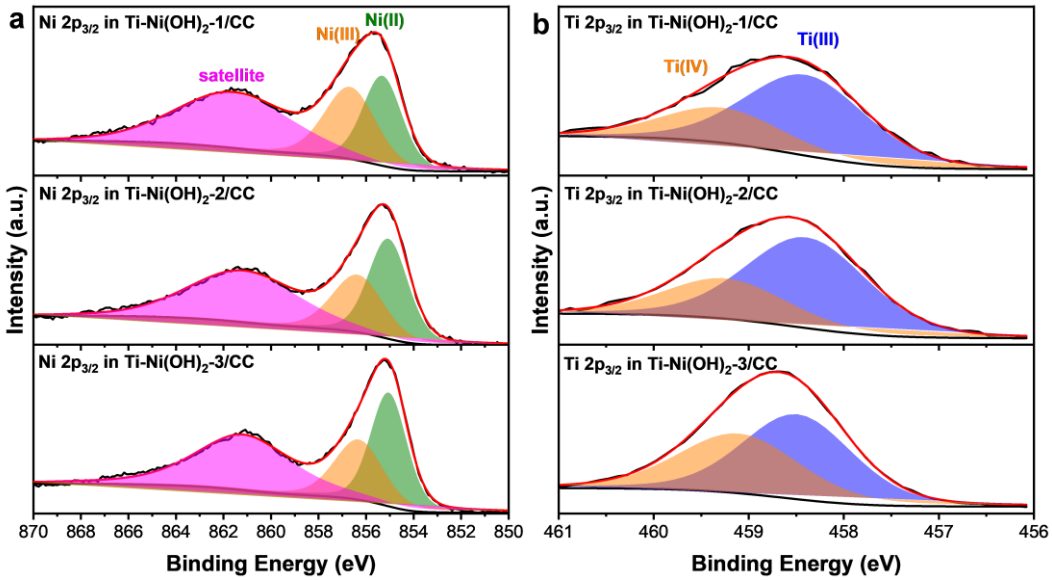

Figure S19. (a) XPS of Ni $2p_{3/2}$ in Ti-$Ni(OH)_2$-1/CC, Ti-$Ni(OH)_2$-2/CC and Ti-$Ni(OH)_2$-3/CC after CP test, respectively. (b) Ti $2p_{3/2}$ in Ti-$Ni(OH)_2$-1/CC, Ti-$Ni(OH)_2$-2/CC and Ti-$Ni(OH)_2$-3/CC after CP test, respectively.

Table S4. Comparison of water oxidation activity with different electrocatalysts in the electrolyte of 1 M KOH.

Materials	electrolyte	Overpotential (mV)	References
Ti-$Ni(OH)_2$/CC	1 M KOH	η_{100}/246	This work
Fe-Ni_3S_2/NF[1]	1 M NaOH	η_{100}/253	[1]
NiFe LDH/NF	1 M KOH	η_{10}/269	[2]
NiCo LDH/NG[2]	0.1 M KOH	$\eta_{145.3}$/400	[3]
NiCo LDH/NF	1 M KOH	η_{10}/271	[4]
NiV LDH	1 M KOH	H_{27}/350	[5]
NiCr LDH/NF	1 M KOH	η_{100}/319	[6]
NiMn LDH/rGO[3]	1 M KOH	η_{10}/260	[7]
NiMn LDH	1 M KOH	η_{10}/350	[8]
NiMn LDH NS[4]	0.1 M NaOH	H_{20}/390	[9]
nNiFe LDH/NGF	0.1 M KOH	η_{10}/337	[10]
NiFe LDH/NF	0.1 M KOH	H_{30}/280	[11]
NiCu LDH/CC[5]	1 M KOH	η_{10}/290	[12]
NiZn LDH/N-rGO	1 M KOH	η_{10}/290	[13]
NiZn LDH nanocage	1 M KOH	η_{10}/290	[14]

1, NF, Ni foam; 2, NG, N-doped graphene; 3, rGO, reduced graphene oxide; 4, NS, nanosheet; 5, CC, carbon cloth;

References

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